

Environmental impact of heating and ventilation systems in a Flemish single-family dwelling

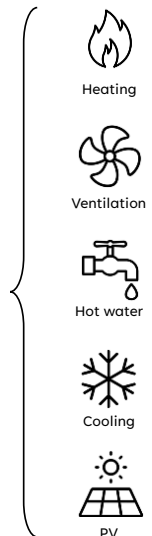
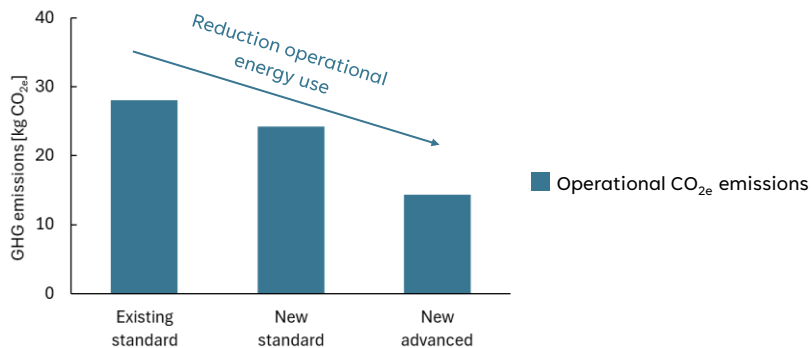
1-2 April 2025, AIVC Workshop Stuttgart

Yanaika Decorte, Ghent University



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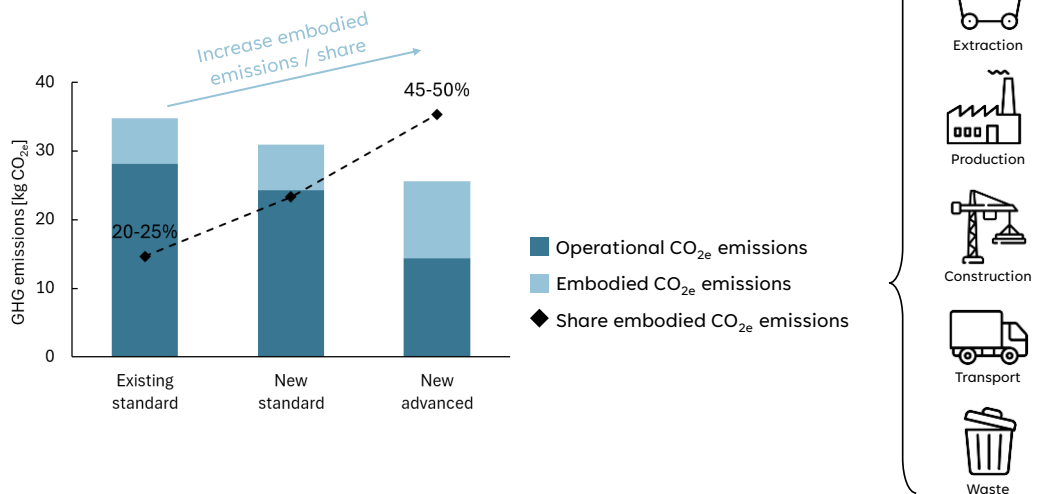
Introduction



Röck et al. (2020). Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation.

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Introduction

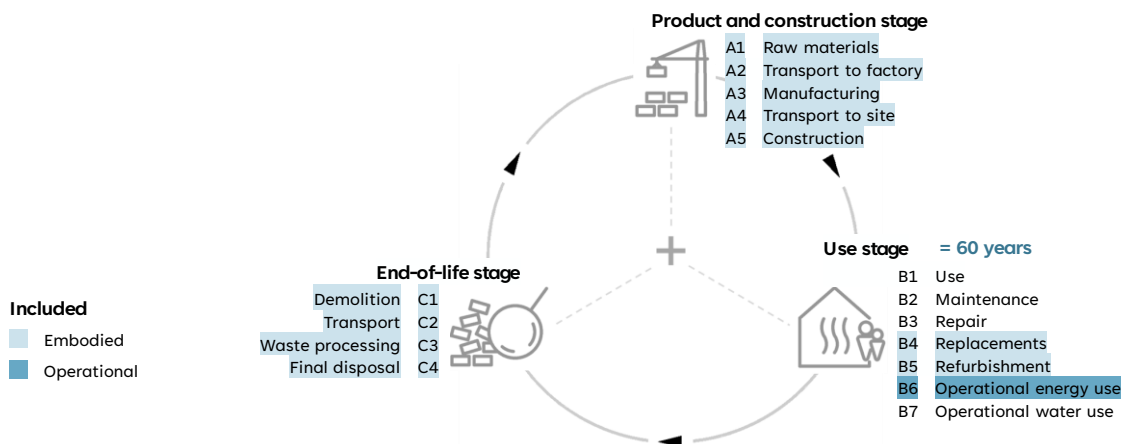


Röck et al. (2020). Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation.

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Life cycle assessment

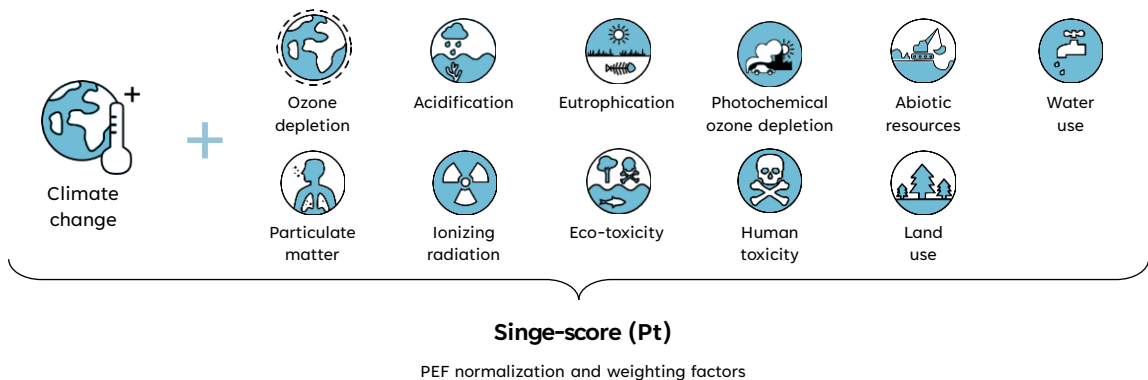
... over its full life cycle



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Life cycle assessment

... considering one or more environmental aspects



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Research questions

1. What is the embodied impact of all individual components in different heating and ventilation scenarios?
2. What is the relative contribution of heating and ventilation systems to the total embodied and life cycle impact?
3. What is the difference between a simplified and detailed approach?

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Case study



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Scenarios



Heating

- Condensing gas boiler with radiators
- Brine-water heat pump with radiators



Ventilation

- Exhaust ventilation with demand control
- Balanced ventilation with heat recovery

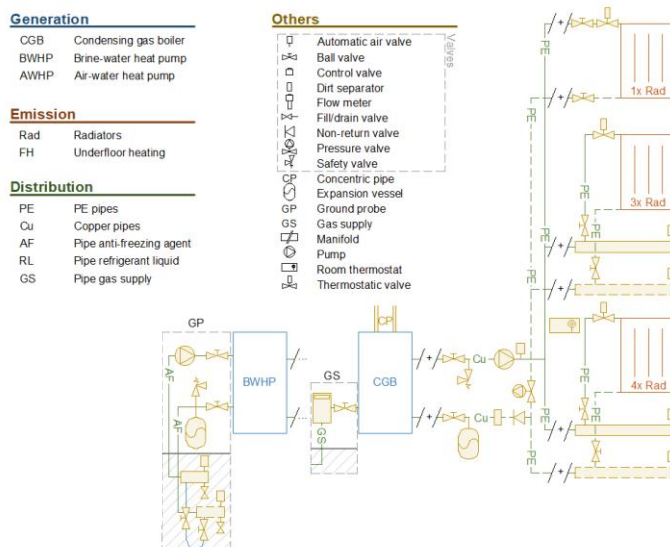
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Research questions

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Data inventory

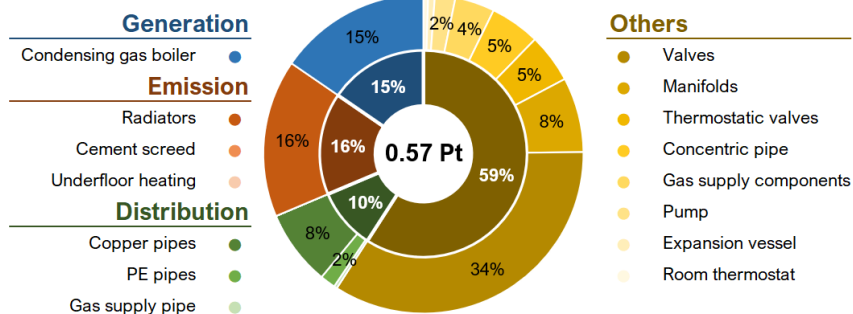


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Heating components



Condensing gas boiler



Important components

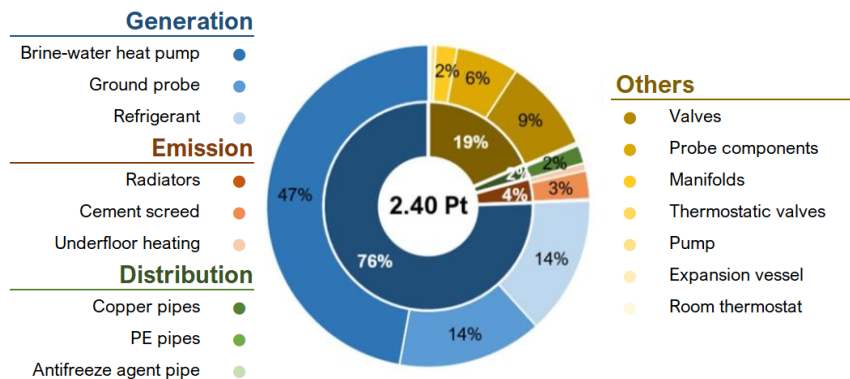
Brass valves > Radiators > Gas boiler

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Heating components



Brine-water heat pump



Important components

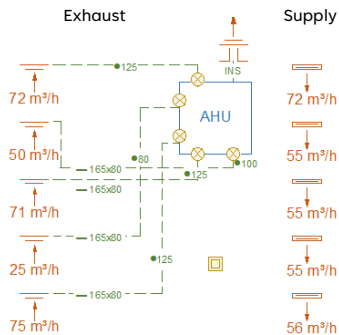
Heat pump > Ground probe & Refrigerant > Valves

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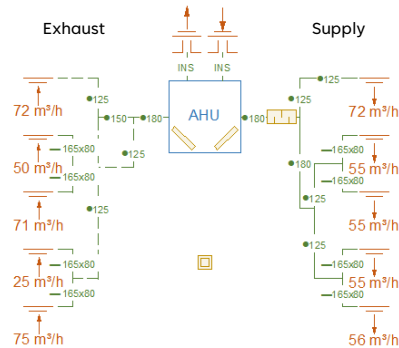
Data inventory



Exhaust ventilation



Balanced ventilation



Generation

AHU Air handling unit

Emission

— Air valves
— Roof hood
— Window vent

Distribution

— Flat duct
— INS Insulated duct
• Round ducts

Others

⊗ Control module
• Filter
□ Silencer
□ Switch

Note: Connectors, bends, T-pieces, reducers, sealing tape, brackets are excluded from the scheme, but are included in the data inventory under 'Others'

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Ventilation components



Exhaust ventilation

Generation

Air handling unit ●

Emission

Window vents ●

Roof hoods ●

Air valves ●

Distribution

Plastic/steel ducts ●

Insulated ducts ●

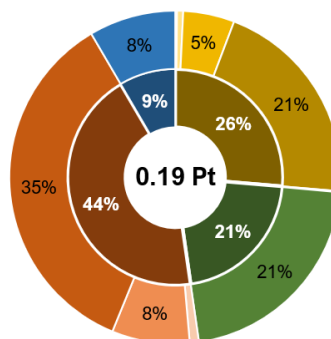
Others

● Control components

● Connectors and bends

● Sealing tape

● Brackets

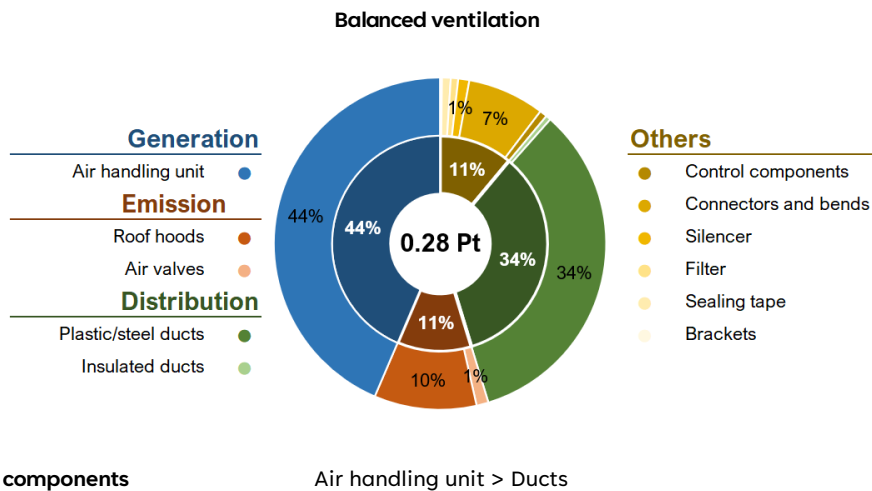


Important components

Window vents > Ducts & Control

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Ventilation components



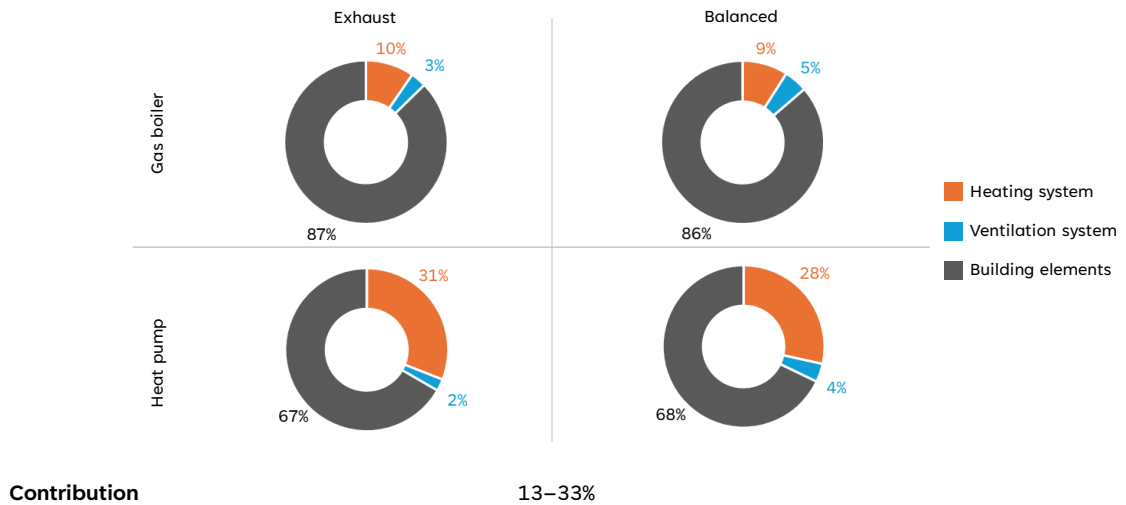
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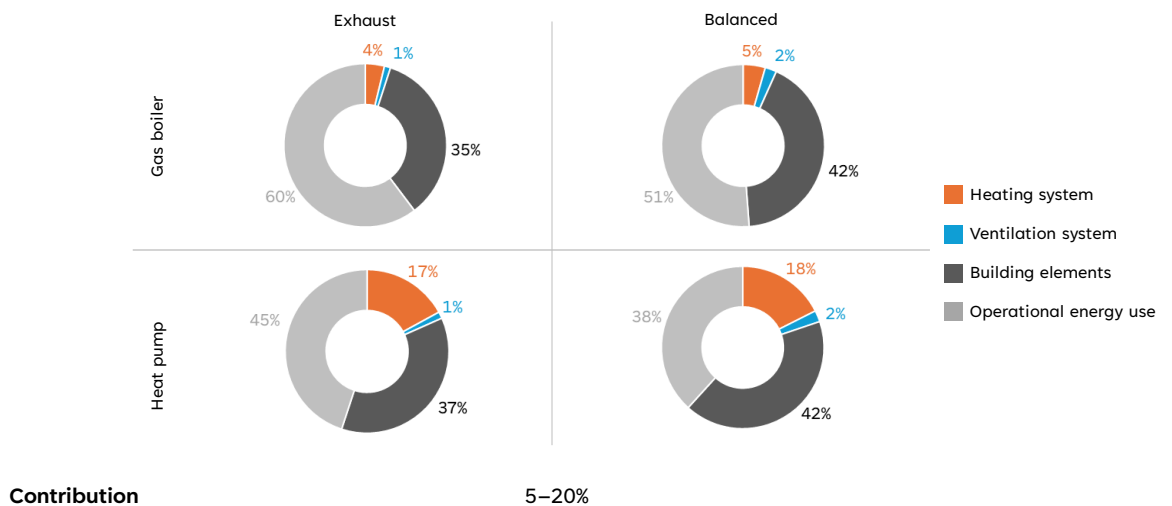
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Contribution to embodied impact



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Contribution to life cycle impact



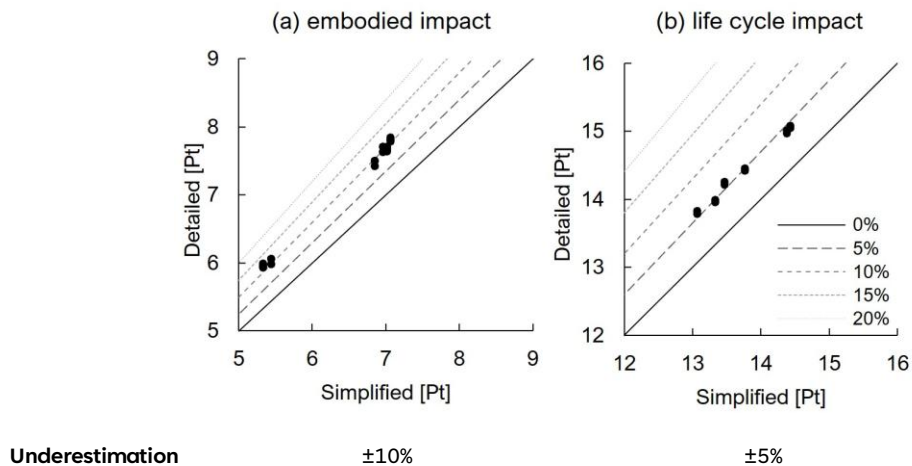
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Research questions

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Error simplified approach



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Conclusions

1. Most important components

Heating

Gas boiler = valves

Heat pump = heat pump

Ventilation

Exhaust = window vents

Balanced = air handling unit



Low embodied impact

High embodied impact

2. Relative contribution

Embodied = 13–33%

Life cycle = 5–20%

3. Error simplified approach Embodied = $\pm 10\%$

Life cycle = $\pm 5\%$

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Limitations

Embodied impact

- Data limitation
- No maintenance included
- Assumed service lives

Case study

Impact indicators

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Yanaïka Decorte

Postdoctoral researcher

yanaika.decorde@ugent.be

More information:

Decorte, Y., Van Den Bossche, N., & Steeman, M. (2024). Importance of technical installations in whole-building LCA: Single-family case study in Flanders. DOI: 10.1016/j.buildenv.2024.111209

Decorte, Y., & Steeman, M., & Van Den Bossche, N. (2024). Comparative LCA of an Exhaust and Balanced Ventilation System: A Single-Family Case Study in Flanders. ASHRAE Conference, 14-19 April 2024, Spain.